

REMARKS:

New claims 20-31 are in the case and presented for consideration. New claim 20 is an independent claim and claims 21-31 depend from new claim 20.

Claims 1-19 have been canceled.

The specification includes support for the new claims. No new matter has been added. For example, Figure 2 of the application shows a DC supply (11) that supplies electrodes (5,9). The polarity of the DC supply, as shown in Figure 2, indicates that the electrodes (5) are cathodes and the electrodes (9) are anodes. See also ¶ 37.

In addition, Figures 3-6 of the application illustrate that the distance between a plasma beam axis and an area of the deposition configuration that faces the plasma beam axis is substantially shorter than the distance between the cathodes (5) and anodes (5).

Favorable consideration of these claims is respectfully requested.

**New Claims 20-31 Are Not Anticipated by or
Obvious from the Cited References**

The office action rejected cancelled claims 1-8 and 18 under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent No. 6,017,396 to Okamoto (“Okamoto”) in view of U.S. Patent 5,753,045 to Karner et al. (“Karner”).

The office action also rejected canceled claim 3 as being unpatentable over Okamoto in view of Karner and U.S. Patent No. 6,015,597 to David.

Canceled claim 17, moreover, was rejected under 35 U.S.C. 103(a) as being unpatentable over Okamoto and Karner et al. as applied to claims 1-8, and 18 above, and further in view of U.S. Patent No. 5,340,261 to Matsumoto et al “Matsumoto”.

Canceled claims 9-16 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Japanese utility model no. JP64-35914A of Nakada in view of Karner and U.S. Patent 5,340,621 to Matsumoto et al (“Matsumoto”).

Applicants rewrote cancelled claim 1 as new claim 20 with the following additional elements:

- (i) “DC” plasma discharge configuration;
- (ii) a pair of “cathode and anode” electrodes;
- (iii) “plasma beam directional” axes;
- (IV) the plasma beam directional axes “each generating a plasma beam with a maximum density peak perpendicular to said plasma beam discharge directional axes”; and
- (V) “each area of said surface (13) being exposed having a distance to the nearest of said at least two plasma beam directional axes which is substantially shorter than said distance between said cathode and anode electrodes of each of said pairs”

For the reasons discussed in detail below, Applicants respectfully submit that this claimed invention is not obvious from Okamoto in view of Karner or any of the other cited references.

(a) “DC” Plasma Discharge Configuration (Claim 20)

The electrodes 11, 12 of Okamoto are supplied by external high-frequency power supply 7, which operates at a frequency of 13.56 MHz or other frequencies, e.g. at 2.45 Ghz, to generate an ECR plasma (col. 7:44-50). The plasma 16 is generated by a RF electric supply, where both electrodes 11 and 12 are of equal extent, and is not attributed to cathode or anode function.

Karner teaches a single plasma beam discharge configuration having a pair of cathode and anode electrodes. In Karner, the plasma discharge configuration formed by the plasma beam discharge configuration is a DC plasma discharge configuration. A deposition configuration is coaxial to the beam directional axis and is cylindrical around such axis. Each area of the deposition configuration is substantially closer to the beam than the distance between the anode and cathode electrode.

Applicants respectfully submit that there is no motivation to modify Okamoto with the discharge configuration taught by Karner. Okamoto teaches directly away from a discharge configuration with a large radius and a large length. In Okamoto, one dimension of the plasma is substantially smaller than the corresponding dimension of the substrate. See, e.g., Okamoto, Fig. 2 and Col. 6: lines 55-64 (which explains that when a substrate is 50 cm on each side, the distance between the electrodes 11 and 12 is only about 8 cm). Okimoto, in pertinent part, states:

"Therefore, in the case where each side of the substrate 15 is 50 cm long, the film formation region does not cover the entire surface of the substrate 15 but covers only the predetermined film formation width 21 (i.e., about 8 cm). This configuration provides an advantage in that the plasma 16 can be formed in a film formation region distant from the substrate 15, thereby minimizing the irradiation damage during the film formation process, although the film formation region is relatively small. The resultant film has excellent interfacial characteristics." Col. 6:line 60 - Col. 7:line 3.

The short sheet-like Rf plasma discharge of Okamoto does not produce the same effect as the multiple, long, focused DC plasma beam discharge of Karner. Karner, in pertinent part, states:

"By generating a long plasma beam 1 and the utilization of an area of low plasma density according to the present invention, simultaneously and therefore extremely economically, a plurality of workpieces or large workpiece surfaces can be treated, in this example, in particular coated,

homogeneously, economically and on an industrial scale. The extremely high plasma density of the heavy-current arc is particularly suitable for depositing high-quality diamond layers on a large surface." Col 5: lines 35-49.

Karner teaches that the plasma density is at a maximum along the beam axis. Col. 1: lines 14-28. Karner uses a relatively low plasma density area along a cylindrical surface coaxial to the single plasma discharge beam. Thus, metastable layers are deposited by maintaining the cylindrical deposition surface looped around the one-plasma beam in an area where the plasma density of such beam is diminished to a predetermined amount.

If the beam discharges of Karner are substituted for the sheet-like plasma discharges 16 of Okamoto, the respective surface 15 would be treated by deposition along a significantly longer distance and, will produce a maximum plasma density adjacent the plasma beams rather than between the electrodes. Such a configuration is contrary to the teaching of Okimoto which indicates that the plasma 16 "does not reach the vicinity of the substrate 15" in the first vacuum chamber. Col. 6: lines 10-18, Otherwise, irradiation damage due to the plasma would result.

(b) "plasma beam with a maximum density peak perpendicular to said plasma beam discharge directional axes" (Claim 20)

Okamoto does not teach two plasma beams with a density peak as claimed in the instant application.

Okamoto teaches that the maximum density forms a linear locus in a plane perpendicular to the discharge direction; Okamoto does not teach a peak. The distance between the electrodes of each pair is substantially smaller than the distance of the parallel planes that are defined from one electrode to the other electrode of the respective pairs.

- (c) “each area of said surface (13) being exposed having a distance to the nearest of said at least two plasma beam directional axes . . . substantially shorter than said distance between . . . electrodes”

In addition, Okamoto fails to disclose or teach that the distance between a work surface (13) and nearest plasma beam directional axes is substantially shorter than the distance between the electrodes.

In contrast, according to Okamoto, the distance between the electrodes is substantially smaller than the distance between the parallel planes which are defined from one electrode to the other electrode of the respective pairs.

Okamoto teaches that each area of substrates 15 is distant from the most neighboring plasma plane by a distance greater than the distance between the respective electrodes 11 and 12.

As shown in Figure 4 of Okamoto, the film formation device has two discharge configurations, each having a pair of electrodes (11, 12). The distance between the electrodes (11,12) is substantially smaller than the distance between the two parallel plasma planes (16) above and below the substrate (15).

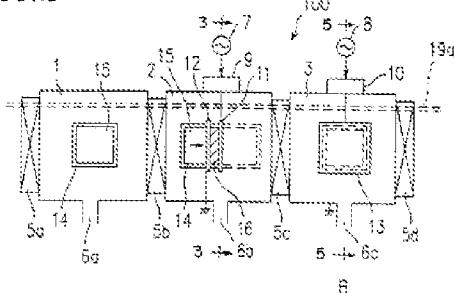
Okamoto, in part, states that “the distance L between the electrodes 11 and 12 is derived to be 7 cm” (Col. 6:50-51) and that “the plasma 16 can be formed in a film formation region distant from the substrate 15.” (Col. 6:60-66).

According to Okamoto, “the substrate 15 is not exposed to the oxygen plasma 16, which is generated in a space between the electrodes 11 and 12 as seen from Fig. 4”. This is to prevent the substrate from being damaged by the oxygen plasma. See Okamoto at Col. 5: lines 55-59. The electrodes 11, 12 are defined from one plate-like electrode to the other plate-like electrode (see fig. 2, 3) of the respective pairs which are side by side and

which are mutually parallel. Okamoto, at Col. 5: lines 65-67 also states, "the plasma 16 is generated in a relatively small region in the first vacuum chamber 2, as compared with the entire area of the substrate 15 (Fig. 2)." Also see Okamoto at Col. 6, lines 10-18, which reiterated that the plasma is created in a "relatively small region interposed between the electrodes 11 and 12 in the first vacuum chamber, so that the plasma 16 does not reach the vicinity of the substrate 15."

Therefore, Okamoto expressly requires the length of the discharge axis extending between electrodes 11 and 12 (i.e., the distance L between the electrodes 11 and 12) to be substantially shorter than the width of the plasma 16. See Fig. 2 of Okamoto (reproduced below).

FIG. 2



The Office Action, in part, states:

"Okamoto teaches a vacuum processing apparatus that includes: two plasma discharge configurations 11, 12 that each have two electrodes (cathode 11, anode 12) two electrodes plasma beams 16 having discharge axis spaced apart parallel to each other and in a low-voltage high-current plasma beam discharge gap between a cathode 11 and an anode 12; a deposition configuration 14 holding two substrates 15, ... which extend a selected distance from the beam axis along a substantial section of the discharge beam longitudinal direction and disposed between the discharge axes; a power supply 7 to independently drive each gap; a gas suction configuration (not shown); and a gas supply section 17, 18 for supplying a silicon containing gas parallel to the discharge axis. (Figure 4 and 6)"

The Office acknowledges that Okamoto does not teach “the discharge axis A is substantially longer than any diameter of said discharge generation areas, a gas flow parallel to the discharge axis that the cathode is a hot cathode or Helmholtz coils to generate a magnetic field parallel to the discharge axis”.

Rather, the Office Action relies on Karner to provide the missing feature of Okamoto, namely:

“a hot cathode plasma beam discharge configuration with electrodes (cathode 3, anode 4) that has a discharge axis A that is substantially longer than any diameter of said discharge generation area, a gas inlet 29 and exhaust 26 that causes a gas flow substantially parallel to the discharge axis, and a Helmholtz coil to generate a magnetic field parallel to the discharge axis. (Entire document, specifically, figures 1, 3, and 3a).”

The Office Action states the following as the motivation for the proposed modification: “to provide an alternate and equivalent plasma discharge configuration, and enable the apparatus to deposit metastable layers as taught by Karner, et al. to control the plasma as taught by Karner et al.”

The Office's proposed modification also renders inoperative and/or changes the principle of operation of the processing apparatus described in Okamoto.

In addition, the film region, which corresponds to the cross sectional area of the plasma, is relatively small and does not cover the entire surface of the substrate but extends across only one dimension (e.g., width) of the substrate. See Okamoto, Col. 6: lines 61-64 and Col. 7: lines 1-3.

The Office asserts that Karner (Figs. 1, 3 and 3a) teaches a “discharge configuration that has a discharge axis A that is substantially longer than any diameter of said discharge

configuration area". See Office Action at page 3, second paragraph. This is contrary to the specific teaching of Okamoto which requires the distance L between the electrodes 11 and 12 to be relatively small when compared with the width of the plasma (see, e.g., Okamoto, Fig. 2, col. 6, lines 11-13). Okamoto's discharge configuration is designed to prevent the plasma from reaching the vicinity of the substrate (see, e.g., Okamoto, Fig. 2, col. 6, lines 13-14). However, Karner teaches that the workpieces are exposed to the plasma.

Karner also teaches that a surface F is obtained which has a large radius r and a large length l (col. 3, lines 58-60 and Fig. 1). Thus, Karner teaches a plasma beam that can cover substantially the entire surface of a workpiece.

Okamoto is directed on a completely different technique and shows a completely different arrangement which may not add to obviousness over Karner per se.

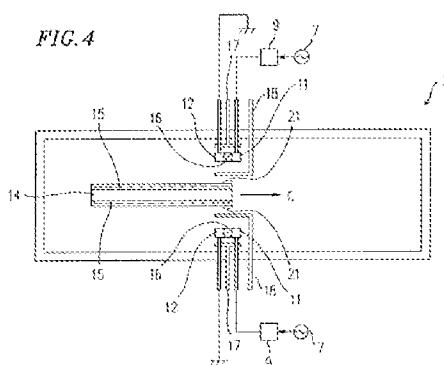
In addition, the proposed modification would change the principle of operation of Okamoto and/or render the modified apparatus inoperative. In Okamoto, the direct exposure of the entire surface of the substrate to the plasma does not occur until the substrate is transferred to the second vacuum chamber 3, then and only then is a large-area plasma employed (Okamoto, Col. 7: lines 22-27).

Furthermore, providing Karner's discharge configuration in the first vacuum chamber of Okamoto would not only expose a large area of the substrate to the plasma, but also cause the type of damage that Okamoto's apparatus was designed to prevent (Okamoto, e.g., col. 5, lines 55-59).

U.S. Patent 6,015,597 to David also does not provide the missing insight to combining Okamoto and Karner. Accordingly, it is believed that new claims 20-31 recite patentable subject matter.

The Office also asserts that Okamoto teaches, "a gas supply section 17, 18 for supplying a silicon containing gas parallel to the discharge axis." See Office Action at page 3, lines 3-4. However, as read by Applicants, Okamoto does not appear to teach this feature. According to Okamoto,

"The gas introduction tube 17 opens in a region between an inner wall of the first vacuum chamber 2 and the opposing electrodes 11 and 12. The gas introduction tube 18 opens in a region between the conveyance path of the substrates 15 and the opposing electrodes 11 and 12... Col. 5, lines 19-24 and Fig. 4 (reproduced below)."



With the openings of the gas introduction tubes 17 and 18 arranged parallel to the discharge axis, it would appear that the gas is discharged perpendicular to the discharge axis.

The Office acknowledges that Nakada does not teach:a second plasma discharge configuration with a discharge axis parallel to the first discharge axis and independently drivable from the first; a gas supply configuration with a gas flow generally parallel to the plasma discharge axis; that the cathode is a cold cathode, or a gas supply system from supply a carbon-, boron-, nitrogen-, hydrogen-, or silicon-containing gas.

The Office Action relies on Karner to provide the missing feature of Nakada, namely, a hot plasma discharge configuration 10 with a pair of electrodes (cathode 32 and

anode 12) for forming a plasma beam 16 with a discharge axis substantially longer than any diameter of said discharge generation areas, and located between and parallel to two planar deposition configurations support 14a, 14b, substrates 28 (substrates 28 are a continuous planar powder capture surface) which extend a selected distance from a plasma discharge configuration axis; and Helmholtz coils 26. (Figure 1 and 3).

The Office Action also relies on Matsumoto to teach two parallel plasma beam discharge configuration with a low voltage high current plasma beam discharge gap between a cathode 2 (hot or cold) and anode 6 that form two plasma beams 7 parallel to each other, a power supply 16 to independently drive each gap, and a gas supply section 26, 27 for supplying a carbon-, nitrogen-, hydrogen-, or silicon-containing gas (entire document).

The Office Action then states using multiple independently controllable plasma discharge configurations to form multiple plasma beams in the apparatus of Nakada et al is to more uniformly distribute the plasma over the substrate as taught by Matsumoto et al.

Applicants respectfully submit that the Nakada, Karner and Matsumoto references teach away from the proposed modification or combination. The Office's proposed modification also renders inoperative and/or changes the principle of operation of the processing apparatus described in Nakada.

Nakada JP 64-35914 teaches generating a disk-like plasma. The plasma which is generated is disk-like shaped as may clearly be seen e.g. from Fig. 1, although generation of such plasma makes use of a source 10 which is, at first, generating a plasma beam which is then spread by magnetic field. Thus, in addition to the difference as cited by the Office between Nakada and former claim 9 there is a further difference, namely, that Nakada spreads the plasma.

Matsumoto teaches, see Fig. 4, col. 6:lines 1-44, two sheet plasmas 7 so that their sheet surfaces are arranged side by side. Thus, Matsumoto, in fact, teaches to double the Nakada one disk-shaped plasma discharge, thereby generating two side by side sheet plasma discharges. According to Matsumoto, col. 6:lines 1-5, the plasma taken out to the vacuum chamber is transformed into thin plane-shaped, sheet-like plasma spreading parallel to the substrate 11, which is established by magnetic field applying means comprising both a plasma inductive coil and a couple of plasma compressive permanent magnets. Thus, similarly to the one plasma discharge of Nakada, Matsumoto teaches generating a sheet-like, thin, plane-shaped plasma spreading parallel to the substrate. Because the disk-shaped plasma discharge of Nakada having a high-density expansion already leads to a treatment of a large surface exposed to and parallel the disk-shaped plasma of high density and equally the double sheet-like plasma discharges of Matsumoto also lead to exposing an even enlarged surface area of a surface to be treated to the sheet-like expanded plasma. There is no motivation to replace the disk-shaped or sheet-shaped spread plasma of Matsumoto or of Nakada by beam-shaped plasma discharges as one as taught by Karner. In comparison to Karner's plasma beams, the disk-shaped or sheet-shaped plasmas of Matsumoto or Nakada act completely different on a respective substrate surface exposed, on the one hand, parallel to the disk- or sheet-shaped plasmas and, on the other hand, parallel to the beam axis.

The beam-shaped plasmas of the claimed invention do not require a high strength magnetic field all along the plasma extents as taught by Matsumoto and Nakada to spread the plasma in disk- or sheet-like shape all along its distance between an anode and a cathode. The extent of surface to be treated can be selected by selecting the respective number of beam discharges.

U.S. Patent 6,015,597 to David also does not provide the missing insight to combining Ikegaya, Karner and Matsumoto.

Applicants have endeavored to make the foregoing response sufficiently complete to permit prompt, favorable action on the subject patent application. In the event that the Examiner believes, after consideration of this response, that the prosecution of the subject patent application would be expedited by an interview with an authorized representative of the Applicants; the Examiner is invited to contact the undersigned at (845) 359-7700.

Applicants respectfully submit that by this response, the application has been placed in condition for allowance and such action is respectfully requested.

Respectfully submitted,

/John Zaccaria/
John Zaccaria
Reg. No. 40,241
Attorney for Applicants
Tel: (845) 359-7700

Customer No. 21706

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NOTARO & MICHALOS P.C.
100 Dutch Hill Road, Suite 110
Orangeburg, New York 10962-2100